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# FOREST RESEARCH NOTES

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## ANNOTATED LIST OF PINE HYBRIDS MADE AT THE INSTITUTE OF FOREST GENETICS

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Pine hybrids produced up to 194[illegible] at the Institute of Forest Genetics were listed in a recent publication to acquaint plant breeders and botanists with the progress of the hybridization work (7)[1]. Numerous requests for information about pine hybrids indicate that a different type of publication on the pine hybridization program is needed; namely, a list of the hybrids by common names of their parental species, giving a digest of our present knowledge obtained from results of tests conducted at the Institute and elsewhere and our surmises about the regions where the hybrids may be of value. This paper is directed at that need.

Most plant hybrids can be expected to be intermediate between their parent species in most quantitative characters. Sometimes hybrids resemble one parent in a certain character, such as resistance to the pine reproduction weevil which the Jeffrey-Coulter pine hybrid inherits from Coulter pine (4). Less frequently, a hybrid may exceed both parents in rate of growth or some other quantitative character. This phenomenon is known as hybrid vigor. Even the truly intermediate hybrid may have some advantages. It may, for example, be able to tolerate the adverse climate to which its slower-growing parent is adapted and in which its faster-growing parent cannot survive. Thus almost any hybrid has potential value and merits at least small-scale testing in the appropriate regions.

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1/ Numbers in parentheses refer to bibliography at end of paper.

* MAINTAINED AT BERKELEY, CALIFORNIA, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA.

Suggestions given here on geographic and climatic adaptability should be recognized merely as suggestions. They are often based not on actual trials or careful studies of comparative climatology, but on information about adaptation of pine species in various parts of the world gleaned from the literature and from conversations with visiting foresters from virtually every major coniferous forest region of the world.

With regard to the availability of hybrid seed for testing or large scale planting by others, some explanation of the Institute's situation and policies is necessary. The Institute wishes to get comprehensive information on the economic possibilities of the hybrids which perform well at Placerville. This information would in the future enable the Institute and other breeding agencies to breed for specific purposes with greater precision than would otherwise be possible. Such information can be obtained only from tests established on suitable sites in various regions in the United States and in foreign countries by cooperators having the knowledge, facilities, and resources requisite for properly conducting the tests. This means that the objectives and methods must be clearly understood and agreed to in advance; that the cooperator must have both control over the area involved and the personnel and means with which to maintain the test and obtain the desired data on performance. As research institutions are best qualified in those respects, the Institute favors them as cooperators; and accordingly most of its cooperative field tests are being conducted by other Forest Service experiment stations and by other research and educational institutions. Wood-using and timber-growing industries and other private parties having the requisite resources are welcomed as cooperators when seed is available. No administrative procedure has been set up to enable the Institute to make its products available for other than scientific purposes, except to the U. S. Forest Service.

Unless otherwise stated, all tests so far made, have been conducted at the Institute of Forest Genetics at Placerville, California, latitude 39° north, longitude 121° west, altitude 2700 feet above sea level. Temperature and precipitation data are as follows:

Temperature and Precipitation

Institute of Forest Genetics

| Month | Max. temp. 1929-37 | Mean temp. 1929-37 | Min. temp. 1929-37 | Precipitation 1930-37 | Snowfall 1928-37 |
|---|---|---|---|---|---|
| | °F. | °F. | °F. | Inches | Inches |
| January | 48.8 | 41.6 | 34.5 | 7.36 | 14.40 |
| February | 53.4 | 45.1 | 36.9 | 7.02 | 1.54 |
| March | 59.5 | 50.1 | 40.7 | 4.42 | 0.63 |
| April | 63.9 | 53.8 | 43.7 | 3.02 | - |
| May | 71.8 | 60.5 | 49.5 | 1.60 | - |
| June | 80.6 | 68.3 | 56.0 | 0.87 | - |
| July | 90.7 | 77.5 | 64.3 | 0.01 | - |
| August | 89.8 | 77.2 | 64.7 | - | - |
| September | 82.0 | 69.8 | 57.6 | 0.26 | - |
| October | 72.6 | 62.0 | 51.5 | 2.05 | - |
| November | 61.6 | 52.5 | 43.8 | 3.24 | 0.61 |
| December | 53.0 | 45.5 | 37.9 | 6.05 | 5.51 |
| Year | 69.0 | 58.7 | 48.4 | 35.90 | 22.70 |

The outstanding features of this climate are long dry summer, mild rainy winter, and occasionally 20 inches or so of heavy, wet snow which damages certain of the introduced pines. The soil at the Institute, Aiken clay loam, has a rather high moisture-holding capacity, and despite the long summer drought, moisture is available to tree roots in the lower horizons. Pot culture tests have shown that the levels of available phosphorus and nitrogen in Aiken clay loam are rather low. The conifers growing spontaneously at the Institute are Pinus ponderosa Laws., P. sabiniana Dougl., P. lambertiana Dougl., Pseudotsuga taxifolia (Poir.) Britton, and Libocedrus decurrens Torr.

In the annotated list which follows, the name of the seed-parent species is given first, the pollen parent second. English names are those given in Standardized Plant Names (3). The year-date which follows is the year in which the cross was first successfully made at the Institute. The list is not a complete catalogue of hybrids produced at the Institute of Forest Genetics (hereafter abbreviated as IFG)--some hybrids unlikely to have practical value are omitted.

1. KNOBCONE x MONTEREY (_P_. _attenuata_ Lamm. x _radiata_ D. Don). 1927.

Described as x _P_. _attenuradiata_ Stockwell and Righter (9). Occurs spontaneously in Santa Cruz County, California. The cross made at IFG utilized the economically-unimportant Sierra foothill race of knobcone pine, which is more cold-resistant but less vigorous than Monterey pine and the coastal forms of knobcone pine. Hybrid is intermediate between the parents in growth-rate, cold-resistance, stem-form, and flowering-time (9).

Should be tested up to 3,000 feet on the west slope of the Sierra Nevada against ponderosa pine, and its more promising hybrids and against other commercially important species of forest trees. At IFG the Monterey-knobcone hybrid appears to outgrow ponderosa pine by at least 10 percent in height and diameter up to 23 years (present age of oldest hybrids). Should also be tested up to 3,000 feet in the Coast Ranges on ponderosa pine and Douglas fir sites. Should be of value on colder margins of areas where Monterey pine is grown successfully (e.g. Australia, New Zealand, South Africa, Spain, Portugal, Chile, Argentine).

Wood tested at Forest Products Laboratory (1) was roughly comparable to that of ponderosa pine in density and longitudinal shrinkage.

2. KNOBCONE x BISHOP (_P_. _attenuata_ x _muricata_ D. Don). 1946.

In early tests at IFG appears to outgrow both parents. Stem form unknown. No recommendations for use can be made at present.

3. SHORE (closely related to lodgepole pine) x JACK (_P_. _contorta_ Dougl. x _banksiana_ Lamb.). 1946.

In early tests at IFG outgrows shore pine and equals jack pine. Depending on development of market for shore pine as source of pulpwood, this may be of value in coastal Oregon, Washington, and British Columbia; possibly also in British Isles, coastal Norway, and Belgium. Stem form unknown.

4. LODGEPOLE x JACK (_P_. _contorta_ var. _latifolia_ Engelm. x _banksiana_). 1939.

Occurs spontaneously in Alberta (5). Described as x _P_. _murraybanksiana_ Righter and Stockwell (6). In tests at IFG, central Wisconsin, northern Idaho, and eastern Massachusetts, outgrows California lodgepole in height and diameter. Early growth about equal to that of jack pine, but in several localities, after several years, the jack pine falls behind the hybrid. Produces cones in third or fourth year. Should be valuable for pulpwood

production. Should be tested in Pacific Northwest, northern Rocky Mountains, Lake States, northern New York, New England, and Ontario, Quebec, and Maritime Provinces of Canada. Likewise in British Isles, northern Europe, northeast Asia, and those parts of Australia and New Zealand where lodgepole pine has been successful.

5. SANTA CRUZ ISLAND x MONTEREY (P. remorata Mason x radiata). 1942.

Grows at about the same rate as both parent species. Has good form. This hybrid should be tested as a potential replacement or alternative type wherever Monterey pine is used. Tests should include resistance to insects such as Sirex noctilio, spider mites, and other pests which, in certain localities, impair the productivity of Monterey pine.

6. JEFFREY x COULTER (P. jeffreyi Grev. & Balf. x coulteri D. Don). 1944.

Occurs spontaneously wherever parent species occur together. In tests at IFG outgrows Jeffrey pine and is somewhat slower growing than Coulter pine. So far, this cross has yielded very low proportions of sound seeds. Therefore, the backcross hybrid listed below is considered of greater practical importance.

7. JEFFREY x (JEFFREY-COULTER) (P. jeffreyi x (jeffreyi x coulteri)). 1939.

Pollen from a natural hybrid (10). Yields of seed of this backcross are very high. Cage-tests at IFG suggest that this hybrid is more resistant than Jeffrey pine to the pine reproduction weevil which has caused high mortality in plantations of Jeffrey and ponderosa pines in northern California. Preliminary results of uncaged tests in localities in northern California, where the insect abounds, give weight to the suggestion. The hybrids grow at approximately the same rate as ponderosa pine, and have equally good stem form and branching habits. In view of the susceptibility of ponderosa pine to the pine reproduction weevil, these circumstances combine to make this backcross the most promising hybrid yet produced for use in the California region. It is therefore being tested, under field conditions, throughout the California pine region. It may not offer any advantage, however, in comparison with ponderosa pine in regions not infested with the pine reproduction weevil.

8. PONDEROSA x APACHE (P. ponderosa x latifolia Sarg.). 1943.

This hybrid outgrows both parent species, and is of great promise for use in the California pine region, and perhaps in southwestern U.S. and northern Mexico. It is susceptible to attacks of the pine reproduction weevil but, due to its greater vigor, it outgrows susceptibility to the insect more quickly than does ponderosa pine. Nevertheless, steps are being taken to introduce reproduction weevil resistance from Coulter pine.

9. PONDEROSA x ARIZONA (P. ponderosa x ponderosa var. arizonica (Engelm.) Shaw). 1946.

This hybrid slightly outgrows ponderosa in height. Its early performance in plantations at 6,000 feet on the Stanislaus National Forest in California is excellent. It should be tested throughout the California pine region, in southwestern U.S., and in northern Mexico.

10. PONDEROSA x MONTEZUMAE (P. ponderosa x montezumae Lamb.). 1946.

In nursery tests at Placerville, this hybrid outgrows ponderosa in height. It should be tested throughout the California pine region, in southwestern U.S., and in northern Mexico.

11. COASTAL PONDEROSA x ROCKY MOUNTAIN PONDEROSA (P. ponderosa x ponderosa var. scopulorum Engelm.). 1941.

The hybrid outgrows the Rocky Mountain variety and equals the coastal and Sierra Nevada forms in tests at IFG. It may, therefore, merit trial in the Rocky Mountain and Black Hills regions where its cold-hardiness must be tested.

12. SHORTLEAF x SLASH (P. echinata Mill. x caribaea Morelet). 1931.

In tests at IFG appears to have narrower crown and finer branches than shortleaf. Potential value seems to be in putting a faster growing, better formed tree on shortleaf pine sites to the north and west of natural distribution of slash pine. May prove to have some value in developing a pine more resistant to fusiform rusts than slash pine, in which case it may be of importance in the general range of slash pine. Should be tested in areas to north and west of natural distribution of slash pine.

13. SHORTLEAF x LOBLOLLY (P. echinata x taeda L.). 1933.

According to unpublished observations, occurs spontaneously in east Texas and perhaps elsewhere. In tests at IFG outgrows shortleaf in height and diameter by about 10 percent, and has shown great resistance to cold in southern Illinois. May be of value on shortleaf sites. Should be tested throughout natural distribution of shortleaf pine.

14. PITCH x LOBLOLLY (P. rigida Mill. x taeda). 1933.

This hybrid grows faster and has better form than pitch pine but in tests in Maryland has seemed inferior to loblolly. It has outgrown loblolly pine in New Jersey, and shortleaf pine in southern Illinois where it appears to be more frost resistant than both loblolly and shortleaf pine. It should be tested north of the distribution range of loblolly pine in pitch pine areas, and in Illinois where it may produce a tree of better form and faster growth than pitch pine.

15. LOBLOLLY x SLASH (P. taeda x caribaea). 1931.

In small test at IFG, this hybrid appears to have somewhat better form than loblolly. May be valuable in bringing a better-formed, faster-growing tree into the loblolly region, and in breeding a slash pine more resistant to fusiform rust. Should be tested throughout the loblolly pine region.

16. SUGAR x ARMAND'S (P. lambertiana x armandi Franch.). 1947.

Yields of seed following this cross are very low. Nevertheless, as Armand's pine is highly resistant to blister rust, this hybrid may be of value in developing blister-rust-resistant sugar pine. The first tests will be inoculation or exposure tests to determine the degree of blister-rust resistance of this hybrid.

17. SUGAR x KOREAN (P. lambertiana x koraiensis Sieb. & Zucc.). 1947.

This cross, likewise, is difficult to make; so far only one seedling has been produced. As Korean pine is highly resistant to blister rust, this hybrid should also be of value in developing blister-rust-resistant sugar pine, and promises to be more cold resistant than the sugar x Armand's hybrid.

18. WESTERN WHITE x EASTERN WHITE (P. monticola Dougl. x strobus L.). 1939.

This hybrid is of special interest because it has outgrown both parent species in numerous tests made at IFG. Several geographic races of both parent species have been used in this cross, always resulting in vigorous hybrids. Therefore, this hybrid should be tested throughout the distribution ranges of both parent species. The finding in both species of individuals which are apparently resistant to blister rust (2), (8), inspires hope that vigorous resistant hybrids will soon be produced.

19. WESTERN WHITE x HIMALAYAN WHITE (P. monticola x griffithi McClell.). 1942.

This hybrid outgrows western white pine and appears to be less susceptible to blister rust than that species. The hybrid grows at about the same rate as Himalayan white pine, but is more drought resistant. The hybrid should be tested throughout the distribution range of western and eastern white pines, but may not be completely cold hardy in the colder parts of these regions.

20. WESTERN WHITE x BALKAN WHITE (P. monticola x peuce Griseb.). 1947.

This hybrid grows no faster than western white pine but may combine cold hardiness and moderate resistance to blister rust. Tests of its susceptibility to blister rust must precede tests of its growth in the field.

21. WESTERN WHITE x (BALKAN WHITE x EASTERN WHITE) (P. monticola x (peuce x strobus)). 1946.

This hybrid grows at about the same rate as the vigorous western white x eastern white hybrid. Its value will depend on the outcome of blister-rust-resistance tests.

22. LIMBER x HIMALAYAN WHITE (P. flexilis James x griffithi). 1947.

In early test at IFG outgrows limber pine by 100 percent in height. Should be of value as a blister-rust-resistant ornamental white pine with greater cold resistance than Himalayan white pine. Should be tested for both rust and cold resistance. Value as a timber tree cannot yet be estimated, but its rate of growth is extremely rapid for white pine.

23. EASTERN WHITE x HIMALAYAN WHITE (P. strobus x griffithi). 1940.

This hybrid has shown good resistance to blister rust in a rigorous exposure test in Oregon. It outgrows eastern white pine and is about equal to Himalayan white and should be tested in the distribution ranges of eastern and western white pines as well as in those parts of Europe where the good growth of eastern white pine is offset by its blister rust susceptibility.

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